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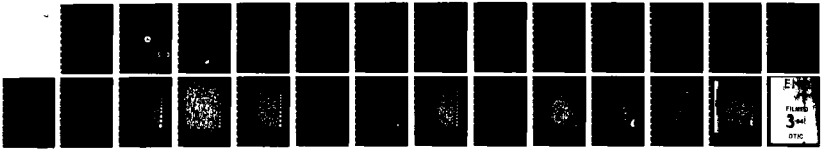

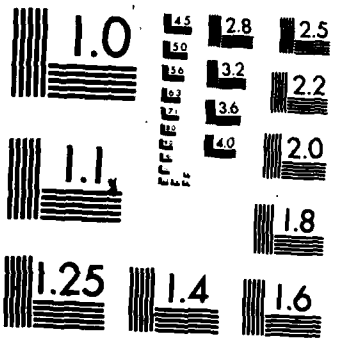

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EVALUATION OF REQUIREMENTS FOR COMMERCIAL NOZZLES ON MERCHANT VESSELS

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U.S. Coast Guard Research and Development Center
Avery Point Groton, Connecticut 06340

NOVEMBER 1983

FINAL REPORT

PREPARED FOR
U. S. DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

OFFICE OF RESEARCH AND DEVELOPMENT
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16. Abstract

An investigation was conducted to evaluate the shipboard firefighting requirements for nozzles used on merchant vessels and to determine if commercial nozzles could replace Coast Guard-approved nozzles. The first phase of the evaluation involved interviewing Coast Guard Marine Inspection Officers and personnel from marine firefighting institutions. They were asked to describe shipboard firefighting requirements and to assess present-day U.S. Coast Guard regulations governing the use of approved nozzles. The second phase of the evaluation involved collecting debris samples from the fire main systems of different merchant vessels and to evaluate the nozzle requirements needed for passing this debris.

The information supplied by Coast Guard Marine Inspection Officers and marine firefighting institutions indicates that commercial nozzles, at present, do not completely address marine firefighting requirements. The collected data indicates that the debris found in shipboard fire main systems is sufficient to clog up commercial nozzle tip openings and to reduce their overall effectiveness. It is therefore recommended that commercial nozzles which do not comply with Coast Guard regulations not be used on merchant vessels.

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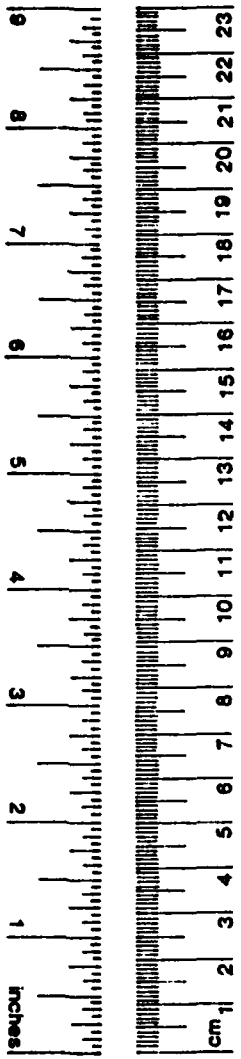
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

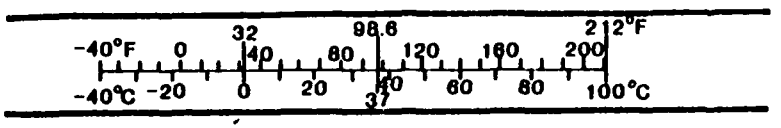
Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	* 2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (WEIGHT)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (EXACT)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (WEIGHT)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (EXACT)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



APPRECIATION

The Research and Development Center expresses its' appreciation to the many Coast Guard Marine Inspection Officers and the individuals of the marine firefighting institutions which offered their expertise and knowledge to assist in the writing of this report.

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EVALUATION OF REQUIREMENTS FOR COMMERCIAL NOZZLES ON MERCHANT VESSELS

1.0 PURPOSE

The requirements for firefighting nozzles used on merchant vessels were evaluated to determine if commercial nozzles could replace the Coast Guard approved nozzles. Presently, commercial nozzles cannot be used on merchant vessels since they do not comply with Coast Guard regulations. This evaluation was undertaken since many nozzle manufacturers contend that although their commercial nozzles do not comply with Coast Guard regulations, they are superior in other firefighting capabilities and should be accepted for use on merchant vessels.

2.0 BACKGROUND

In the last decade, firefighting nozzles have been improved through technology to allow the firefighter to direct the right amount of water in the correct form to the correct place. Today many manufacturers contend that their commercial nozzles are superior in design and performance to those presently approved by the U. S. Coast Guard for use on merchant vessels. Manufacturers cite that research and development innovations have increased the firefighting capabilities of their nozzles to exceed the all-purpose nozzles presently being approved. These improvements include greater nozzle performance, increased control of straight streams and fog patterns, and improved nozzle durability. Also included are tighter straight streams which reach greater distances, adjustable fog patterns, variable flow rates, increased flow rates, and nozzles which automatically react as the flow rate fluctuates. In addition, nozzle weight has been reduced by the use of new construction materials.

It should be noted, however, that in conversations with nozzle manufacturers, they indicate that their commercial nozzles are not specifically oriented toward shipboard firefighting requirements. They also state that it is not possible to modify their existing nozzles to meet Coast Guard regulations and still retain their superior performance characteristics. At the same time, they also indicate that it would be too expensive to design and build such a nozzle unless they have a guaranteed market.

3.0 COAST GUARD REGULATIONS

The Coast Guard regulations for all-purpose nozzles used on merchant vessels are determined from shipboard firefighting requirements. These regulations require that the all-purpose nozzles must pass certain size debris in order to prevent their clogging while in use.[1] For example, approved 1-1/2 inch nozzles must pass debris the size of a 3/8-inch diameter ball while 2-1/2 inch nozzles must pass debris the size of a 1/2-inch diameter ball. The water for firefighting purposes is pumped from a sea chest inside the vessel. This water often contains debris which has passed through the existing strainers in the sea chest. It is suggested that this debris would be more apt to clog nozzles with smaller openings than those with larger openings. These regulations also require the nozzles to be designed for using an applicator with a low velocity fog head. This applicator is intended for

directing a fine protective spray pattern in front of a firefighter. It is also used for directing a fog pattern over or around an obstruction such as the coaming of a cargo tank or the bulkhead of a berthing area. In addition, the nozzle body must be constructed of bronze for use in a corrosive environment.

Commercial nozzles with their advertised improved capabilities are not approved for use on merchant vessels since they do not meet existing Coast Guard regulations. The reasons for the commercial nozzles not being approved are:

(1) They have smaller diameter tip openings which will not pass the required ball.

(2) They have no provision to handle an applicator.

(3) In some cases they are constructed of materials considered poorly suited for use in a marine environment or fire situations.

If an investigation of these requirements indicates that they are no longer valid then an evaluation and comparison of the commercial nozzles to the approved all-purpose nozzle might be worthwhile. If commercial nozzles can comply with present-day Coast Guard regulations then an evaluation and comparison would also be in order.

4.0 APPROACH

The approach used two phases to investigate the shipboard firefighting requirements on which Coast Guard regulations are based.

The beginning phase of this project was conducted by contacting Coast Guard Marine Inspection Officers at major seaports in the United States.[2] These officers were asked to utilize their experience and knowledge to describe present shipboard firefighting requirements. They were also asked to comment on how Coast Guard regulations governing these requirements might be changed to become more effective. The Marine Firefighting Division at Texas A&M University and the Navy Firefighting School at Norfolk, Virginia, were also contacted and asked for their comments.[3, 4]

The next phase involved the inspection and investigation of the fire main systems of merchant vessels at several seaports. This investigation was performed by a project manager with the assistance of Coast Guard Marine Inspection Officers. As the officers inspected merchant vessels in their districts, the fire main system was charged, a hydrant was opened, and any debris flushed from the system was collected. The debris size and its quantity were documented by photographs. Its composition was also determined. In addition, several all-purpose nozzles were examined for rust and "freeze up" conditions. Photographs were taken of any problem areas on the nozzles.

5.0 DISCUSSION

5.1 Nozzle Requirements

The Coast Guard Marine Inspection Officers and the Marine Fire School Instructors were extremely helpful in answering questions and in providing useful information for this evaluation.[2,3,4] Their knowledge and expertise in the problems of shipboard firefighting provided an extensive overview of the requirements necessary for nozzles being used on merchant vessels.

(a) Nozzle Requirements for Passing Debris

It was stated by all Marine Inspection Officers (MIO) that marine firefighting nozzle tips need large diameter openings to pass debris found in the fire main system and that present nozzle regulations should not be changed to permit the use of nozzles with smaller tip openings. Even though many of the commercial nozzles have a flush setting, it was their opinion that the smaller nozzle tip openings would be more prone to clogging when used on a merchant vessel. They also indicated that the nozzle operation should remain as simple as possible with few if any adjustments being made during its operation. It was felt that flush mechanisms, variable flow and numerous pattern settings would only confuse the non-professional firefighting merchant seaman who would probably have received limited training and experience in their use.

Based on MIO observations, considerable debris has been found in the fire main systems of numerous vessels they have inspected. Although strainers are located in the sea chest and before the fire pump to deal with this debris, sea animals (small fish, shellfish, plankton, shrimp), sea growth (seaweed, algae, kelp), ice (in cold climates), and other contaminants (rags, rust, scale) were reported as being flushed from hydrants when opened. Certain types of debris were also reported to be more abundant in certain geographic waters than in others. The principal clogging contaminant mentioned was rust. Although it varied in size, pieces up to two inches long had been reported in both galvanized iron and steel fire main piping systems. Corrosion of this piping depends upon factors such as water temperature, oxidation rates, galvanic attack by ferrous metals and air. It was reported that the longer a vessel had been in service, the more serious the corrosion in its fire main piping. The rate of pipe corrosion caused by alternate exposures to seawater and air has been found to be over four times the rate caused by continuous immersion in seawater.[5]

(b) Low Velocity Fog Applicator

The high velocity tip on approved nozzles can be replaced with an applicator extension for producing a low velocity fog. This applicator is designed to produce a fine water fog curtain for specific firefighting situations. These include (1) providing fog protection to a nozzle crew fighting a fire, (2) cooling down hot metal surfaces to prevent ignition of cargo or flashbacks, and (3) for projecting a localized firefighting water curtain around a corner, over a coaming or into a compartment without exposing the operator to the flames. It was the major consensus that the applicator provides a needed capability for handling these specific fire situations found on merchant vessels.

It should be reported, however, that some personnel with extensive fire training backgrounds indicated that these situations could be handled by commercial nozzles in the hands of adequately trained and skilled firefighters.

(c) Nozzle Construction

It was expressed that approved nozzles should be sturdy in construction and have as few working parts as possible. Brass, bronze or non-ferrous materials resistive to corrosion were indicated as the only materials applicable for use in a marine environment. It was the overriding view that existing nozzles of light alloy materials are not suited for marine use because they can corrode, "freeze up", and thereby fail to function. A case history was reported in which hose fittings made of similar light-alloy materials (anodized aluminum) were used in a marine environment and had to be replaced in approximately six months time. It was also felt that chrome-plated steel nozzles might chip and crack when dropped on the deck or dragged over obstructions. Corrosion could then form in those pitted areas and as more chrome peels off, the nozzles could eventually corrode and fail to function.

Experiences have shown that when ships venture into hot areas such as the Persian Gulf, plastic couplings can and do crack badly after a short period of time.[6] It is felt that plastic nozzles would suffer similar fates. Plastic nozzles were also felt to be unsuited for cold climates because certain plastics easily crack when subjected to sharp blows in extreme cold. It was also feared that plastic nozzles would melt when exposed to either a fire, its radiant heat, or a hot bulkhead.

5.2 Debris Sampling

Debris samples were collected from twelve merchant vessels (Table 1). The sample collection was performed by a project manager with the assistance of Coast Guard Marine Inspection Officers. Vessels were inspected as soon as possible upon their arrival at port. One sample collection was conducted aboard each vessel. The collections were made from the nozzle locations listed in Table 1. The hydrant used to collect the sample was one which would normally have little use while the vessel was in transit. One sample was collected from a nozzle location in the lowest point in an engine room to insure that a worst case area would be examined. No difference was noted in the quantity or size of debris collected at this point when compared to samples collected from on-deck nozzle locations. During the collection process, the hose line on the hydrant was uncurled and its nozzle removed. A fine mesh nylon net was attached over the end of the hose. The fire main system was charged and the hydrant was opened for five minutes. In some cases the nylon net was attached directly over a hydrant opening.

The quantity of debris which was collected did not agree with the expected quantities indicated by conversations with Coast Guard Marine Inspectors. In reality, far less debris was collected than had been expected. A possible explanation for this was that each vessel had previously flushed its fire main system three to fourteen days before the sample had been collected. Therefore, the samples were not indicative of the debris found in a fire main system which had not been flushed recently .

TABLE 1
INFORMATION ON INSPECTED FIRE MAIN SYSTEMS

Vessel Collection	Type	Built	Location Boarded	Date Sample Collected	Nozzle Location	Fire Main Piping Material	Fire Main Last Purged Before
YANKEE	Ferryboat	1919	New London, CT	10 June 82	Forward Main deck	Mild steel	14 days
QUONSET	Ferryboat	1910	New London, CT	10 June 82	Midship main deck	Mild steel	13 days
BLOCK ISLAND	Ferryboat	1915	New London, CT	10 June 82	Midship 03 deck	Mild steel	10 days
POINT SUSAN	Bulk carrier	1958	Mobile, AL	23 June 82	Midship main deck	Low carbon steel	14 days
ELIZABETH LYKES	Bulk carrier	1966	Pensacola, FL	24 June 82	Forward main deck	Low carbon steel	10 days
TEXACO GEORGIA	Oil tanker	1964	Providence, RI	16 July 82	Midship 03 deck	Mild steel	5 days
GULF SUPREME	Oil tanker	1959	Providence, RI	16 July 82	Forward main deck	Mild steel	5 days
COVE RANGER	Oil tanker	1953	Tiverton, RI	16 July 82	Forward main deck	Mild steel	3 days
GULF SOLAR	Oil tanker	1959	Boston, MA	19 July 82	Forward main deck	Steel	1 day
AMERICAN LEGACY	Container vessel	1954	Boston, MA	20 July 82	Midship main deck	Steel	3 days
SS MORMACALTAIR	Container vessel	1955	Boston, MA	30 July 82	Midship	Steel	3 days
SS AMERICAN ACE	Container vessel	1953	Boston, MA	24 May 83	Midship lowest point in Engine Room	Steel	3 days

Coast Guard regulations require merchant vessels to provide weekly fire drill training for its crew. At this time fire pumps are to be started and a sufficient number of outlets used to ascertain that the system is working.[7] Although no requirement is made to flush the entire fire main system, it appears that if this action is carried out, the system can be cleared of debris which could clog a nozzle during its use.

Ninety-eight percent of the collected debris was rust (Figures 1-11). A magnet was used to confirm most of the debris as being iron oxides. Paint chips, greaseballs, fish scales, and pieces of rubber gaskets were also recorded. The largest rust particle was approximately 5/8 inch long by 1/2 inch wide by 1/8 inch thick. The gasket material was larger than the rust particle and measured 1-3/8 inch long by 5/8 inch wide by 1/8 inch thick.

6.0 RESULTS AND CONCLUSIONS

Because all the inspected fire main systems were flushed within fourteen days before the sample debris was collected (Table 1), it is felt that the collected debris did not represent the total normal occurrence existing in a system not regularly flushed. U. S. merchant flag vessels are required to have weekly fire drills, to start their fire pumps and to use a number of hydrant outlets to ensure that the system is working. It is likely, however, that some sections of the fire main systems go unflushed for long periods of time resulting in debris accumulating in the system. This would depend on how thorough the regular maintenance of the fire main system is or on freezing weather conditions which might require the system to be maintained dry for a period of time. Based on the amount of debris which was collected, it is recommended that fire main systems be flushed periodically to prevent an accumulation which could clog a nozzle during its operation. It was noted that vessels operated in shallow waters had a greater quantity of mud in their systems than those vessels operating in deep water.

It was expressed by those interviewed that the materials used in nozzle construction should be highly corrosive resistive, and that the nozzle should have as few working parts and controls as possible. Although the fog applicator was considered effective for its intended purposes, it was reported to have a few problem areas. For example, the spring latch used to release the high velocity tip from the nozzle sometimes freezes into position and the low velocity applicator cannot be used. In addition, the attachment end of the applicator sometimes becomes smashed out-of-round and will therefore not fit into the nozzle. Gaskets used in nozzles, hoses, and piping should also be checked and replaced regularly as they offer a potential hazard for nozzle clogging.

Coast Guard Marine Inspection Officers and instructors from Marine Firefighting Institutions indicated that Coast Guard regulations should not be changed to allow the use of commercial nozzles on merchant vessels. Based on their experience, they indicated that the approved nozzles should be easy to operate, require little training, perform clog-free, and be highly corrosive resistant. They stated that nozzles complying with Coast Guard regulations met these requirements. They did agree that in the hands of a skilled and well-trained firefighter the commercial nozzles would probably be more effective than the approved fog applicator, but they also pointed out that the

smaller diameter tips, flush mechanisms, and variable controls for flow and patterns created potential problem areas which offset any possible firefighting advantage which might be gained by their use. In addition, they agreed that most seamen do not have nor would they probably receive the training necessary to utilize the full potential of the commercial nozzles.

Coast Guard regulations governing the size of nozzle tip openings originated in 1953 in a meeting conducted between Coast Guard personnel and nozzle manufacturers. The results of this meeting were the approval of nozzle tip sizes and the supposition that smaller nozzle tips should not be approved for use since they would be more susceptible to clogging. Data collected from the debris sampling does indicate that the debris found in shipboard fire main systems is sufficient to clog commercial nozzle tip openings thereby reducing their effectiveness. This was determined by passing the debris through several commercial nozzle tips. The greatest portion of the collected debris could have passed through a commercial nozzle with a flush setting, but not all commercial nozzles have a flush setting. This type of limiting characteristic on the effectiveness of a nozzle is difficult to ascertain but from a firefighting point of view any clogging of the nozzle is to be avoided if possible. It is therefore recommended that commercial nozzles not be used on merchant vessels since they do not adequately address shipboard firefighting requirements and fail to comply with Coast Guard regulations.

A more complete study of nozzle tip requirements would require that a greater number of debris samples be collected. This increased number of samples could then be used to provide confidence levels for the probability of clogging. It could also be used to determine the statistical significance of clogging in large populations of merchant vessels.

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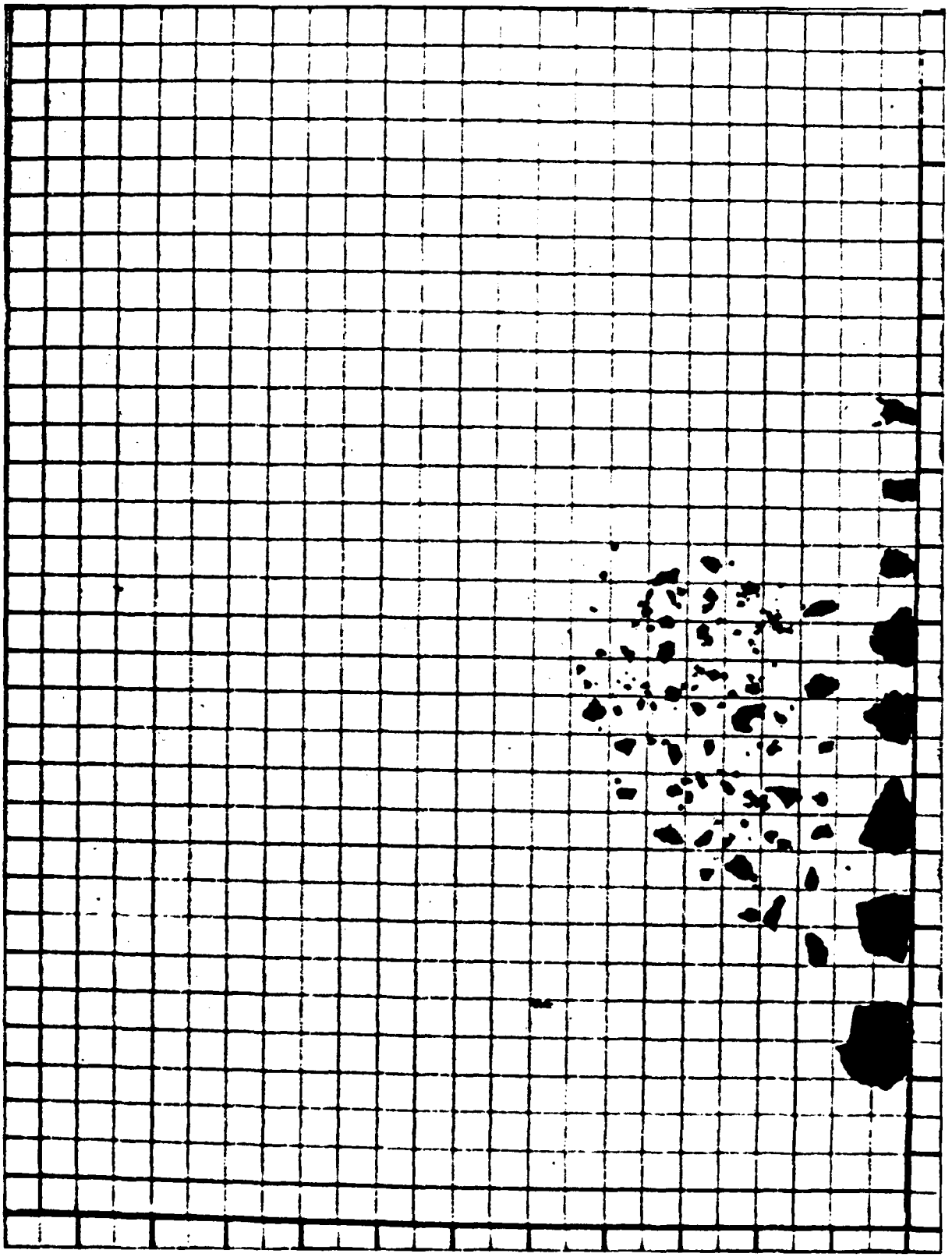
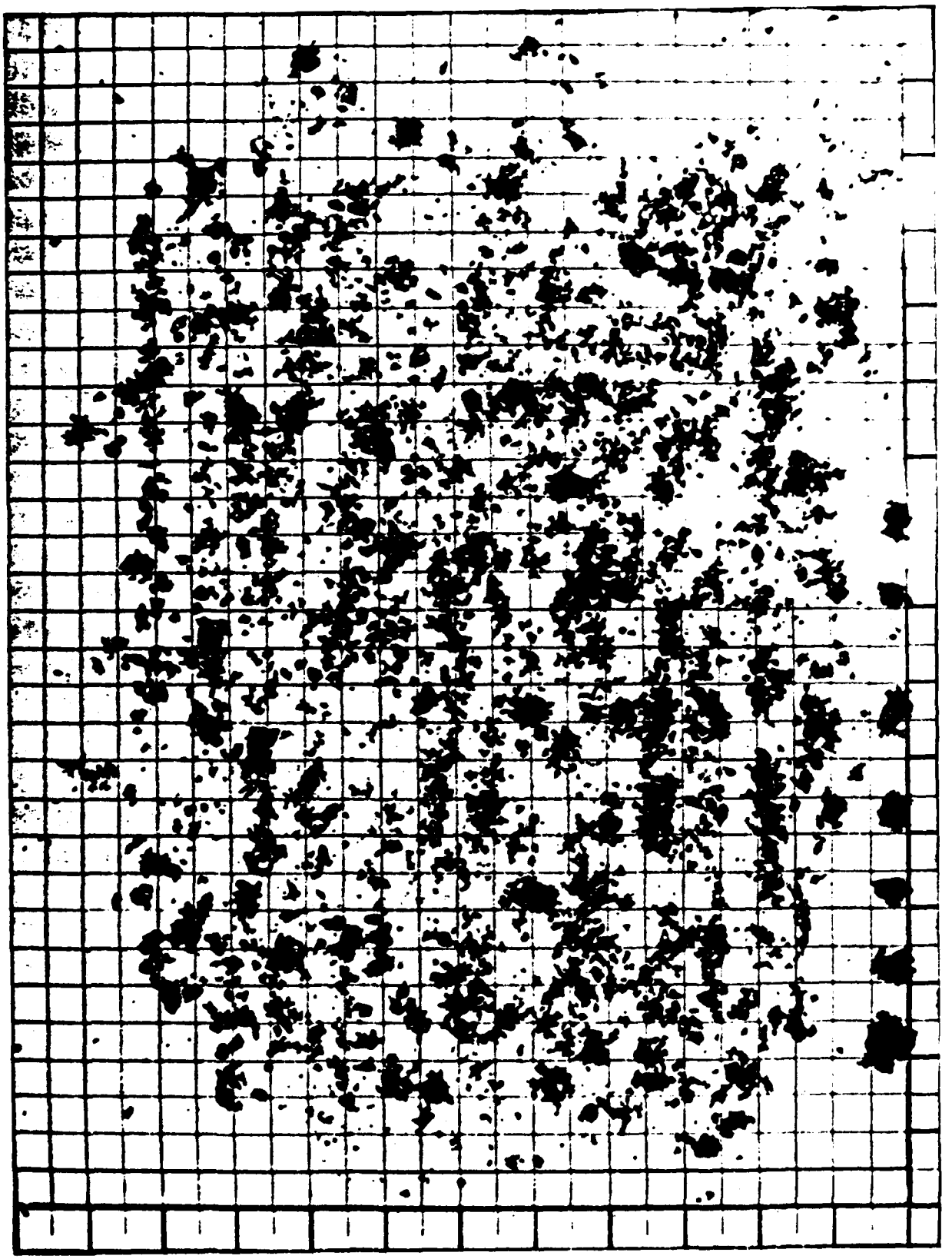


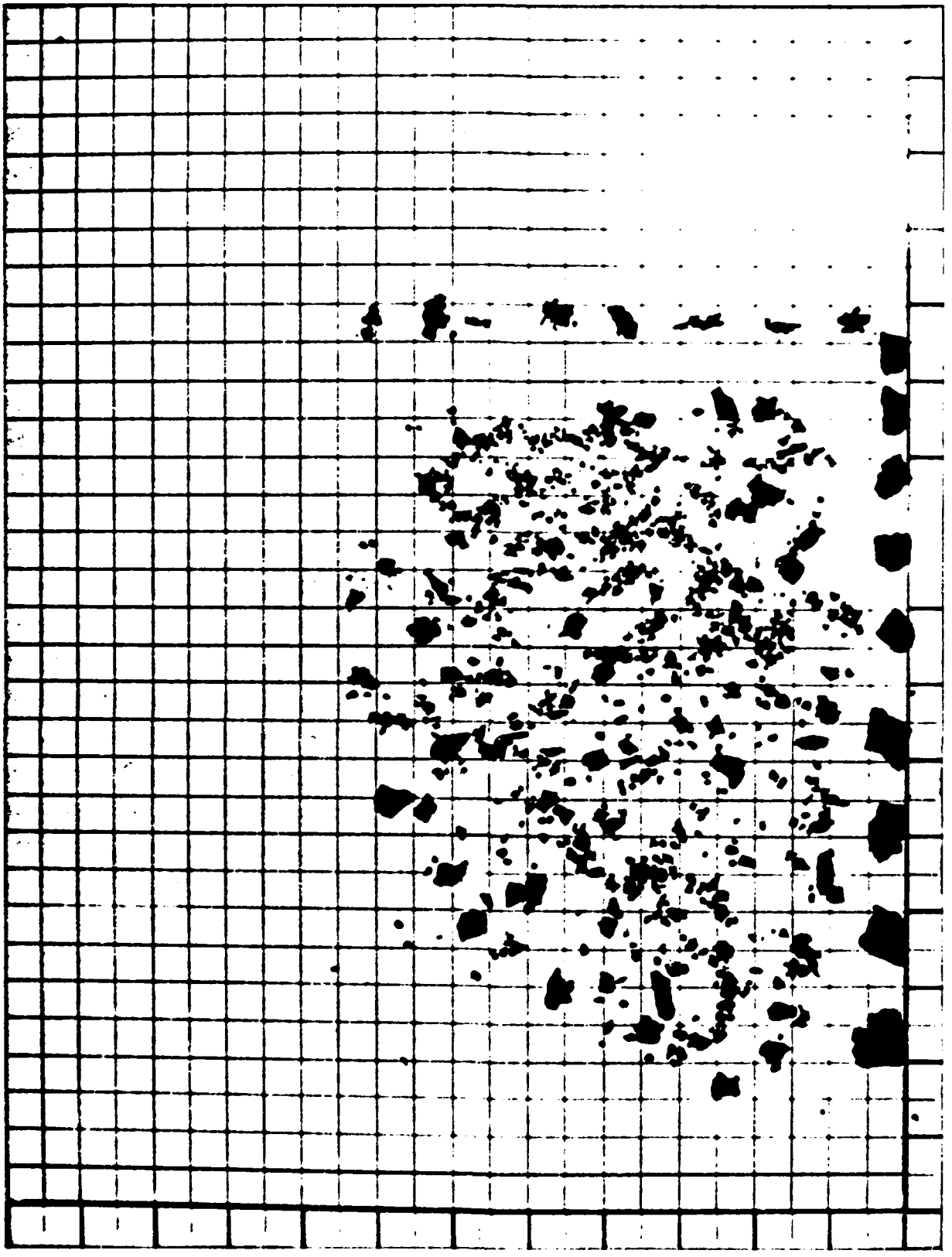
Each Square Equals 1/4"

FIGURE 1. Fire Main Debris from YANKEE



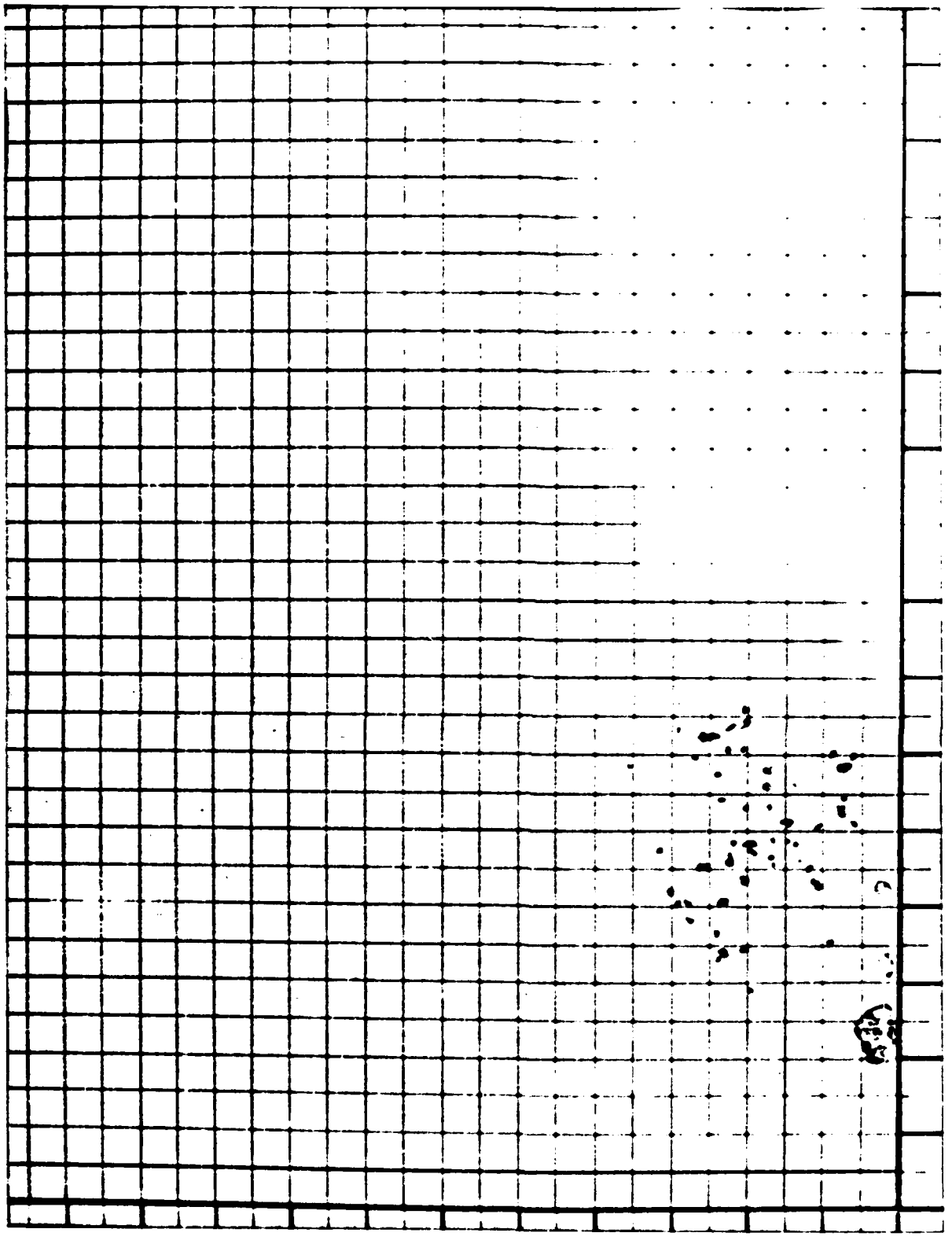
Each Square Equals 1/4"

Figure 2. Fire Main Debris from QUONSET



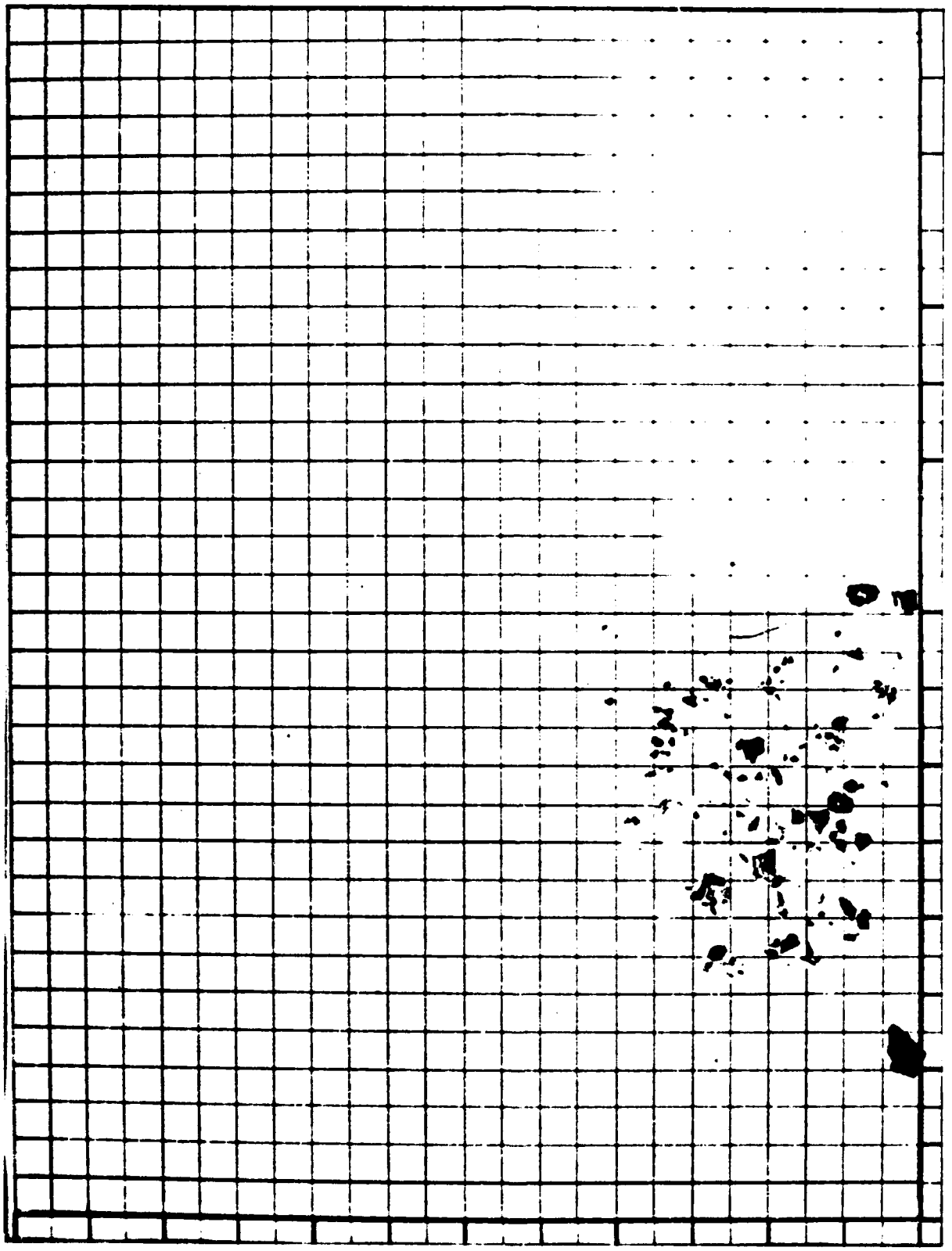
Each Square Equals 1/4"

Figure 3. Fire Main Debris from BLOCK ISLAND



Each Square Equals 1/4"

Figure 4. Fire Main Debris from POINT SUSAN



Each Square Equals 1/4"

Figure 5. Fire Main Debris from ELIZABETH LYKES

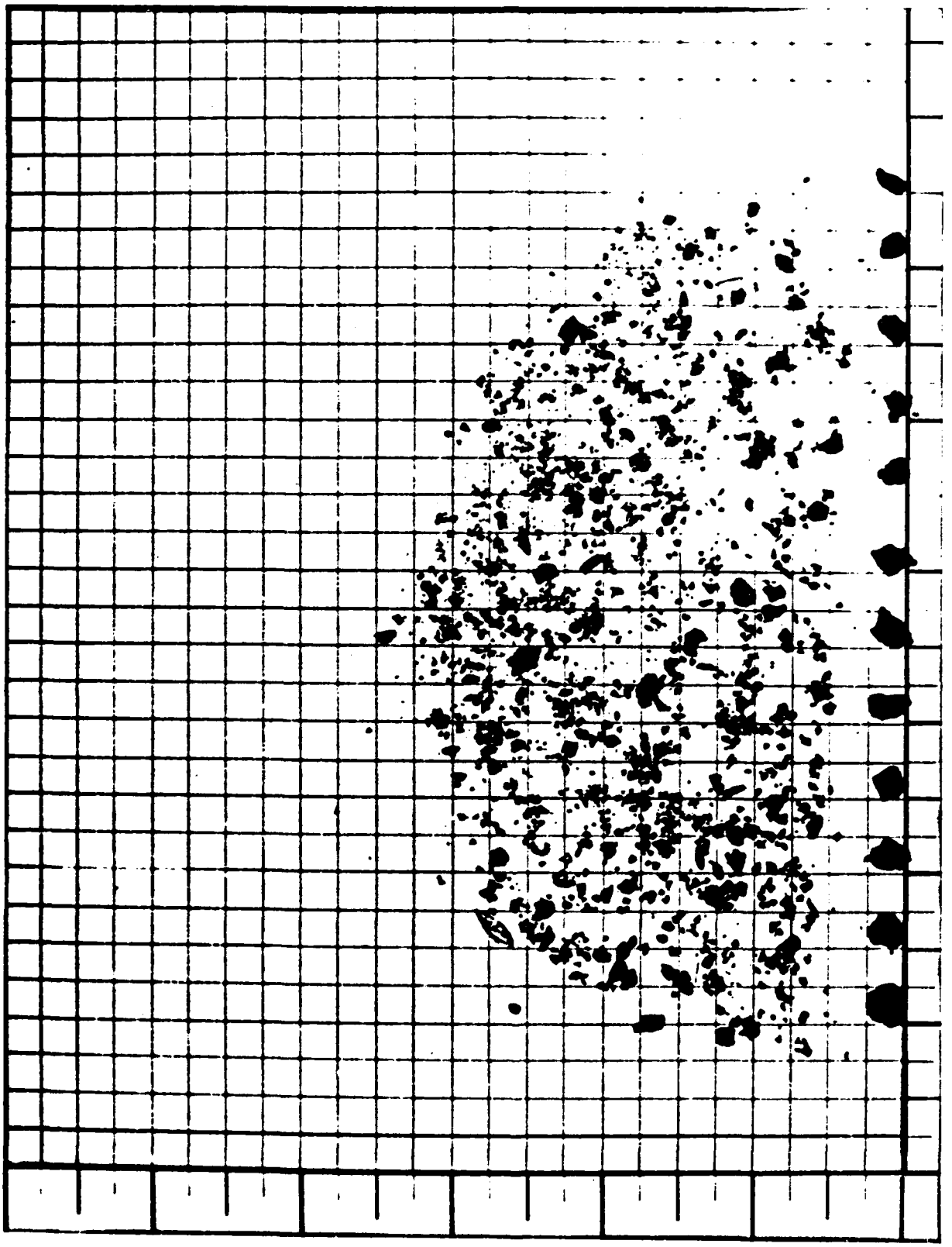


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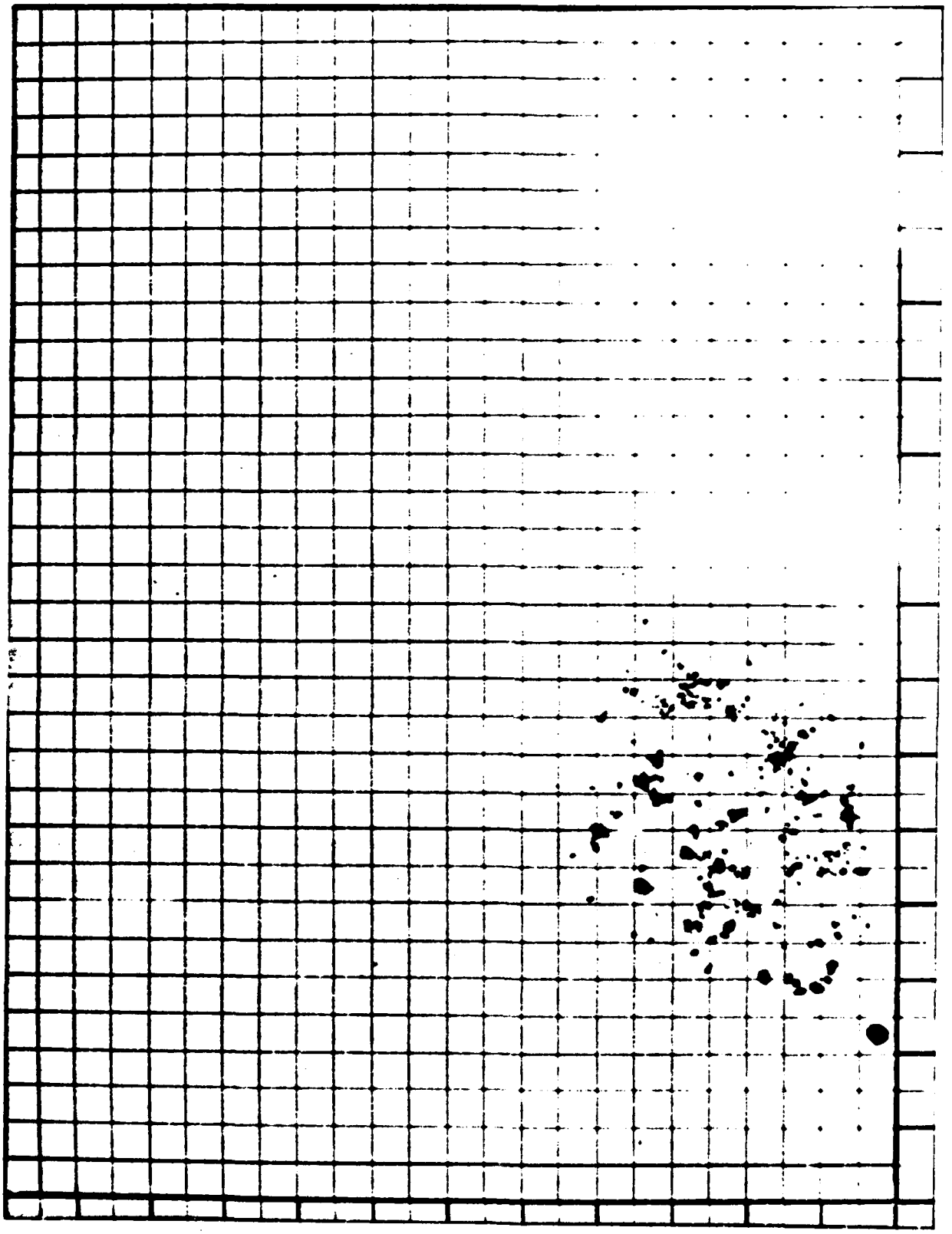
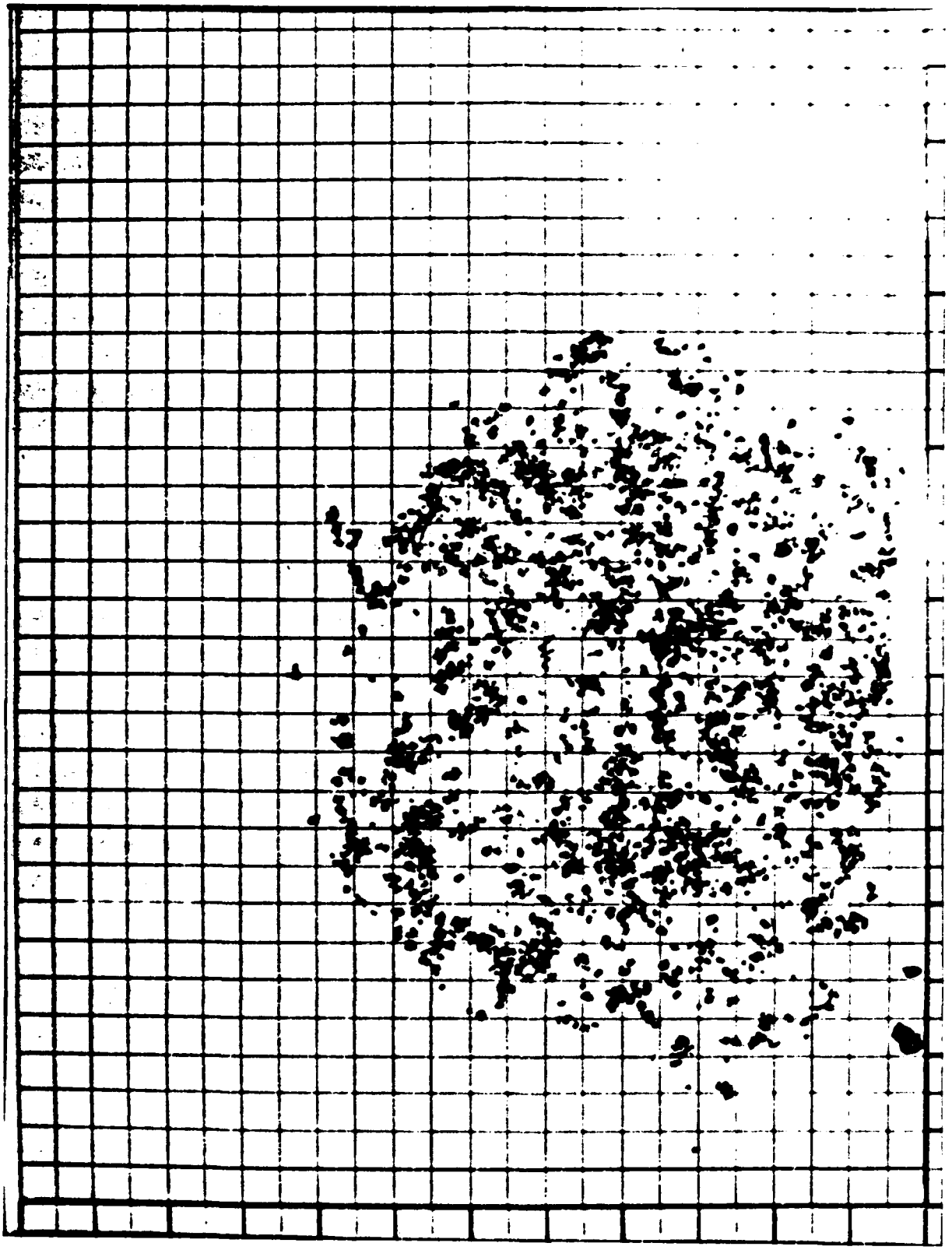
Figure 6. Fire Main Debris from TEXACO GEORGIA



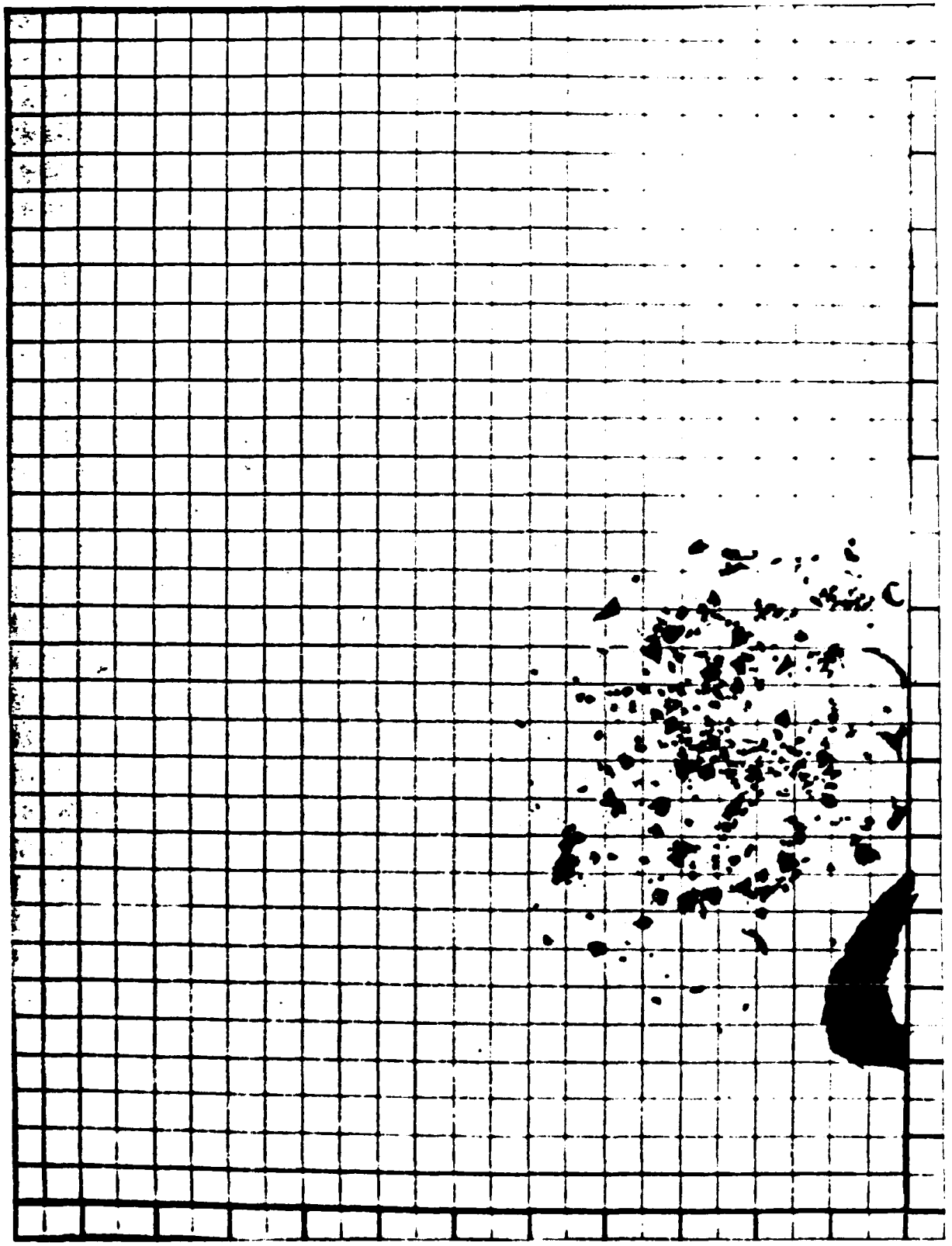
Each Square Equals 1/4"

Figure 7. Fire Main Debris from GULF SUPREME



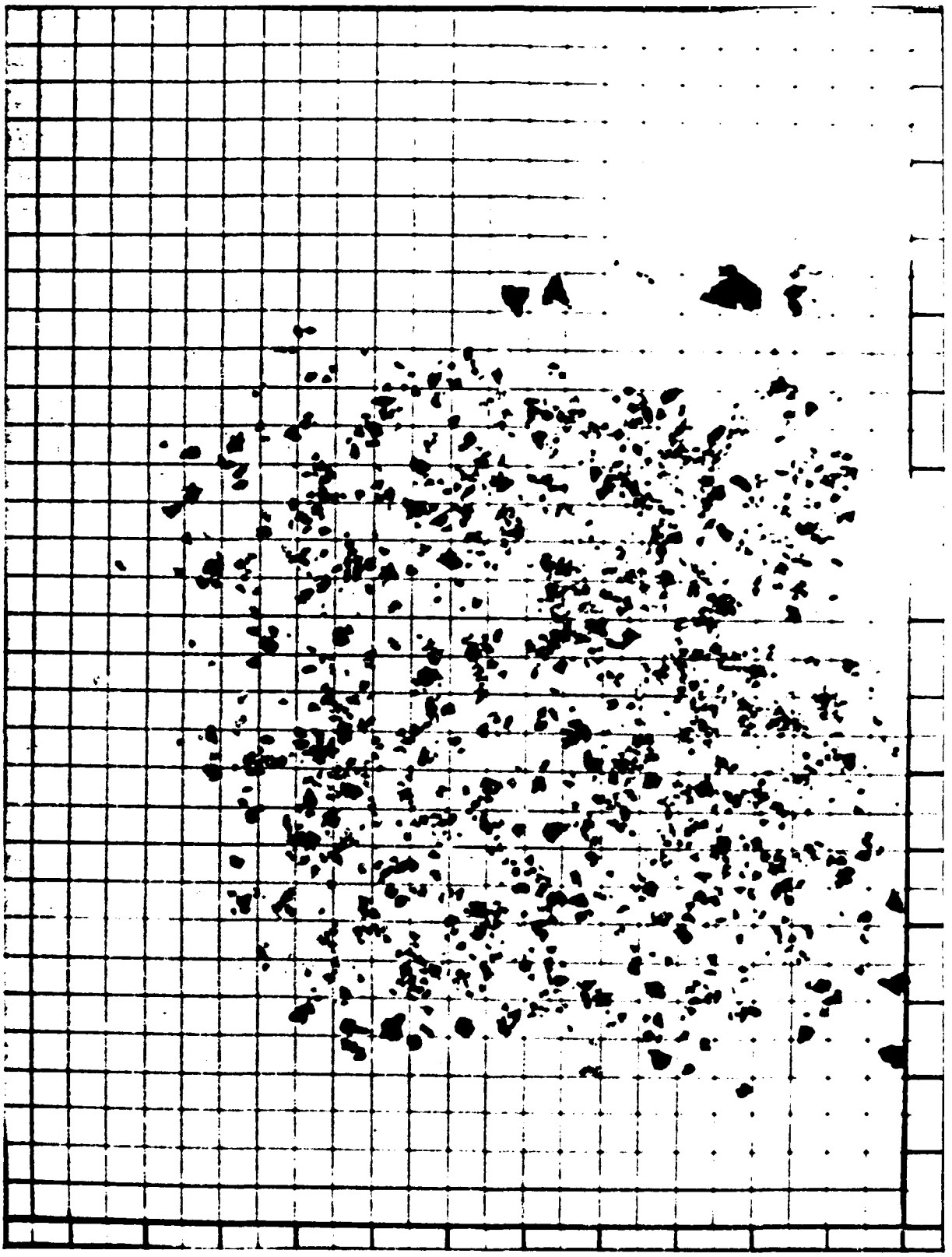
Each Square Equals 1/4"

Figure 8. Fire Main Debris from COVE RANGER



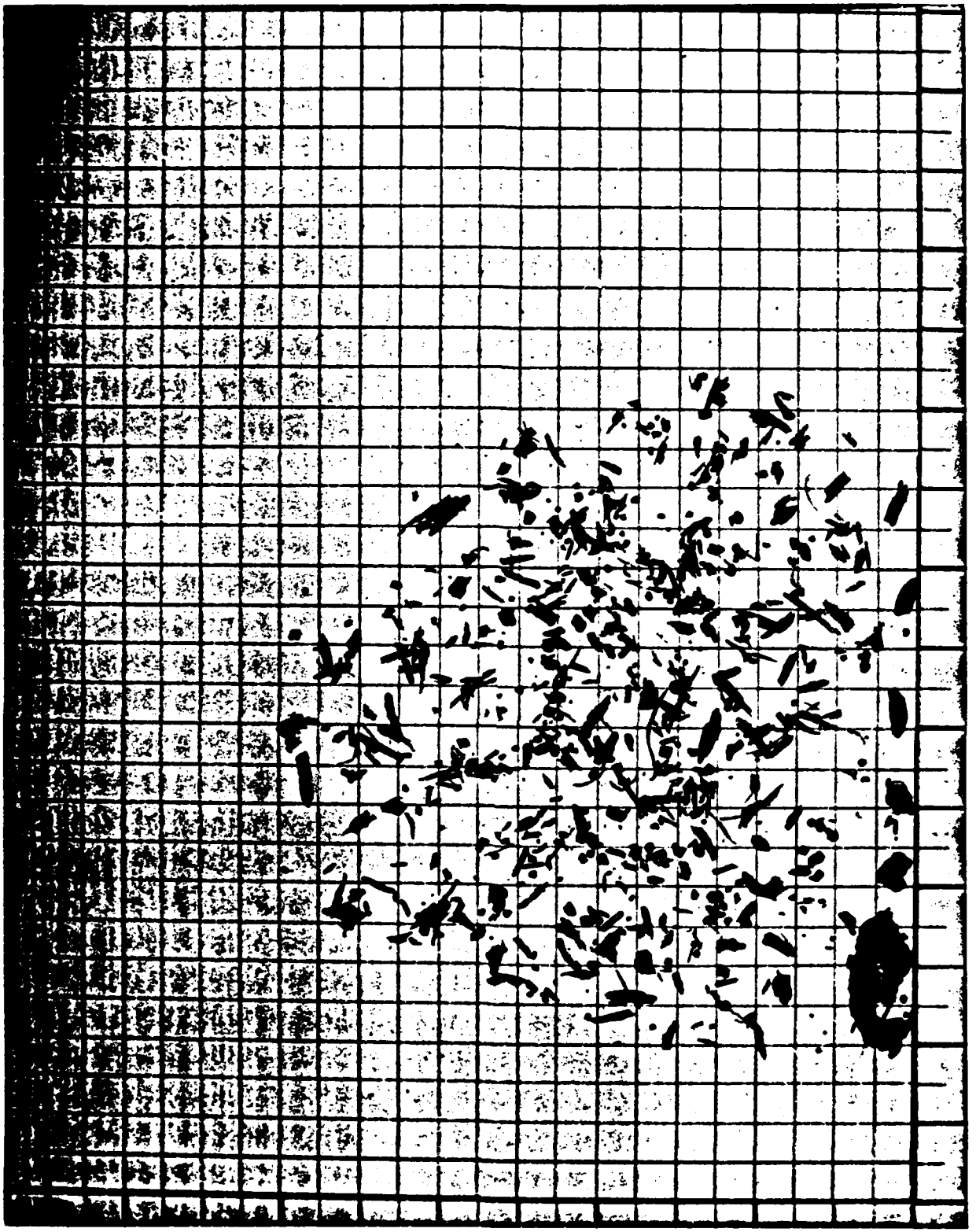
Each Square Equals 1/4"

Figure 9. Fire Main Debris from GULF SOLAR



Each Square Equals 1/4"

Figure 10. Fire Main Debris from SS MORMACALTAIR



Each Square Equals 1/4"

Figure 11. Fire Main Debris from SS AMERICAN ACE

END

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